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Improving Sustainability Concept in Developing Countries

Towards Sustainable Management of Solid Waste in Egypt

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Abstract

The impact of waste accumulation can be highly drastic for many communities in developing countries. In Egypt, the issue gets more challenging as there are no clearly-defined strategies for an efficient management of solid waste, which inflicts serious environmental risks on Egyptian communities and drains a considerable portion of the local economy. This study aims to improve solid waste management in Egypt by exploring the options by which solid waste can be sustainably managed, and reviewing international models of sustainable management systems. Eventually, a strategy is formulated for the sustainable management of solid waste on the local scale of Egypt.

Peer-review under responsibility of IEREK, International experts for Research Enrichment and Knowledge Exchange

Keywords: sustainability; solid waste management; Egypt

1. Introduction

Solid waste management is becoming a major public health and environmental concern in urban areas of many developing countries. Particularly in Egypt, the public sector has been unable to provide the required services effectively, as the existing regulations are still very limited and the local taxation system is inadequate, while the illegal disposal of domestic and industrial waste remains a common practice. In general, solid waste management has been given a low priority in Egypt so far. This is reflected in the limited funds appointed to solid waste management by the government, and the level of services offered for the protection of public health and the environment. Improper solid waste management leads to substantial negative environmental impacts, including health and safety problems such as diseases associated with different forms of pollution.

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1.1. Characterization of solid waste

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, agricultural, etc.), according to its contents (organic materials, glass, metal, plastic, paper, etc.), or according to its hazardous potential (toxic, non-toxic, flammable, radioactive, infectious, etc.). The term municipal solid waste (MSW) is normally assumed to include all of the waste generated in a community, with the exception of waste generated by municipal services, treatment plants, industrial and agricultural processes [1].

1.2. Principal phases of solid waste management

The activities involved in the management of solid waste from the point of generation to final disposal can be grouped into six main phases [1]:

- Waste Identification.
- Handling, separation, and storage at the source.
- Collection.
- Transfer or transport.
- Processing and transformation.
- Disposal.

However, a proper management of solid waste is achieved through the development and implementation of a variety of tools such as legislations, enforcement procedures, capacity of waste recovery and recycling, as well as the presence of infra-structures and facilities for safe handling, treatment, and disposal of such waste [2].

2. Sustainable methodology for solid waste management

A sustainable methodology for solid waste management must consider an integrated waste management system which can be defined as the selection and application of suitable techniques, technologies, and programs to achieve specific waste management objectives that correspond with the local needs and conditions [2].

2.1. Elements of integrated solid waste management

There are four basic management options that can be identified for an integrated waste management system: source reduction, recovery (by reuse or recycling), waste treatment (thermally or biologically), and land-filling.

2.1.1. Source reduction

A strategy for waste reduction at the source is the most important component of any effective management system. Reduction includes any action that reduces the volume or toxicity of waste prior to treatment or disposal [3].

2.1.2. Waste recovery

Recycling and reuse of materials concern the recovery of certain waste types to be used in new products, in addition to the conversion of certain types of waste into energy.

A) Reuse

Reusing products delays the need for producing new products and land-filling the existing ones. When reuse is possible, it is sometimes a better strategy than recycling. Recycling requires additional energy and machinery to separate, process, and manufacture existing products into new ones [3].

B) Recycling

Recycling refers to the removal of items from the waste stream to be used as raw materials in the manufacture of new products [4]. Although recycling can be profitable and benevolent in most cases, a cost/benefit analysis must be conducted before the recycling option is chosen, as costs of recycling versus those of land-filling greatly vary from one place to another [3].

2.1.3. Waste treatment

When waste cannot be prevented or minimized through reuse or recycling, then there is a need for strategies aimed at reducing waste volume or toxicity by using treatment technologies before disposal [1]. Treatment methods are selected based on the composition, quantity, and form of the waste materials.

A) Thermal treatment

This involves the use of heat to treat waste as a way of recovering energy which can be used in heating or producing electricity. Thermal treatment processes can reduce the solid waste going into a landfill by as much as 80–90% in volume and 65–75% in mass [3]. Moreover, safe and preferable thermal treatment processes are described below [4]:

- Incineration, which is based on the combustion of waste in the presence of oxygen.
- Pyrolysis and gasification, which are used to decompose organic waste in a medium of high temperature and low oxygen, or no oxygen at all.

B) Biological treatment

This refers to processes that aim for the decomposition of organic waste, including:

- Composting, which involves biological processes that transform organic waste into a soil conditioner by controlling waste decomposition rates in the presence of air and a variety of microbes [3].
- Anaerobic digestion, which uses biological processes to decompose organic waste in an oxygen-free environment and the presence of bacteria only. This is also a method of producing biogas to generate electricity [4].

2.1.4. Landfill disposal

Waste management processes cannot completely eliminate the need for landfills. Yet, waste disposal in landfills remains the least desirable strategy. However, there are two main landfill types for proper waste disposal as listed in the following [4].

A) Sanitary/secure landfills

Sanitary landfills are usually placed in areas where land features act as natural buffers between the landfill and the environment, while other safety measures are integrated into their design to prevent disposal risks (Figure 1). Moreover, secure landfills are those authorized to accept toxic waste, as they have much stricter safety precautions.

B) Controlled dumps

Controlled dumps are disposal sites which comply with most of sanitary requirements but they have a planned capacity with less control measures. However, they are fenced or enclosed, which reduces the risk of environmental contamination. In addition, they are characterized with lower initial and operational costs.

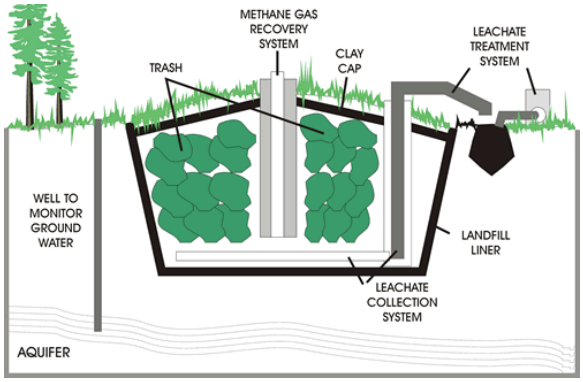

Figure 1. Features of a modern sanitary landfill [4].

3. Leading models of sustainable solid waste management

In the following, leading models from various countries are demonstrated through the perspective of their adopted strategies for solid waste management. The selection comprises cases of developed countries like the United States of America, state members of the European Union, and the case of an Asian developing country, Nepal.

3.1. The United States of America

Today, most American communities use an integrated waste management system to deal with their solid waste. The U.S. Environmental Protection Agency (EPA) has collected and reported data on the generation and disposal of waste in the United States for more than 30 years. The information was used to measure the success of waste reduction and recycling programs across the country. In 2011, out of 250 million tons of generated solid waste, almost 87 million tons were recycled and composted; equivalent to a 34.7% recycling rate [5]. The American strategy for solid waste management includes the major elements explained in the following.

A) Promoting awareness of source reduction

Local government agencies, businesses, and civic groups educate people through programs that suggest simple source reduction tasks that everyone can take part in, thereby encouraging individuals to reduce waste at home. Additionally, companies and organizations reduce waste on a larger scale, as EPA sponsors a national program which works with businesses to identify and implement innovative and cost-saving waste reduction measures [3].

B) Escalating recovery rates

A large part of municipal waste is salvaged as raw materials through recycling or composting, or as energy through incineration. In 1994, the regulations of Resource Conservation and Recovery Act (RCRA) came into force, imposing tighter regulations on every landfill nationwide. The next year, an estimated 27% of that year's solid waste was recovered, surpassing the agency's goal of 25% recovery [3]. Recent projections indicate that the overall recovery rate reached up to 34.7% as of the year 2011 [5] (Figure 2).

C) Empowering community recovery programs

In addition to the country wide-spread markets for reused and refurbished products, material recovery facilities, also known as Intermediate Processing Centers (IPCs), employ hand-sorting and various types of machinery to produce recovered materials in large quantities [3]. Currently, there are over 9,800 recycling programs beside 3,090 composting programs nationwide [5].

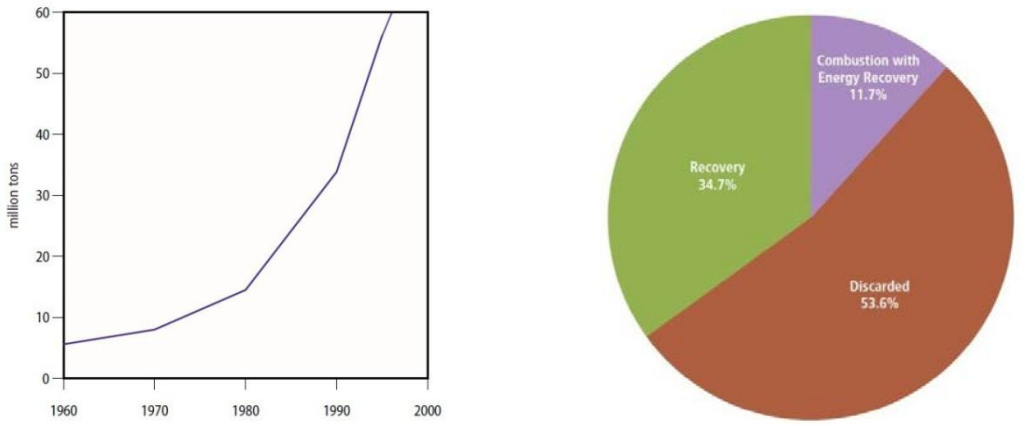

Figure 2. (a) Annual recycling rates of municipal solid waste 1960 - 2000 in USA [3]; (b) Management of municipal solid waste in USA [5].

D) Thinking beyond waste

Besides recovery options, EPA has been employing a systemic approach called Sustainable Materials Management. This approach seeks to use materials in the most productive way over their entire life cycle with an emphasis on using less, as well as reducing toxicities and environmental impacts. Data on municipal solid waste generation, recycling, and disposal was an important starting point for such an approach [5].

E) Federal landfill regulations

The Resource Conservation and Recovery Act (RCRA) of 1976 in combination with the Toxic Substances Control Act (TSCA) provided the legal base for the federal regulations of sanitary landfills. In 1991, EPA established new stricter landfill requirements which now serve as the basis for all state landfill regulations. Those regulations substantially address location restrictions, operating requirements, groundwater and emission monitoring, closure and post closure precautions, as well as cost. Moreover, the Civil Rights Act directs federally-funded programs to identify and address human health and environmental effects on low-income populations by waste disposal [3]. As a result, the number of U.S. landfills has steadily declined over the past years, while the average landfill size has increased. At the national level, landfill capacity appears to be sufficient for the current disposal practices [5].

3.2. The European Union

The European Union has been promoting solid policies in correspondence with sustainable waste management. Fundamental objectives were placed in the thematic strategies of the EU 6th action plan for the environment in 2005. Those given polices were meant for the expansion of recovery practices and the reduction of waste volume sent to burials. Thereby the Union issued a series of regulations, directives, and decisions which determine the objectives that the state members are called to achieve, and the time frame during which this must be done. The principal targets of the EU for solid waste management are found in the Directive - Frame "About Solid Waste" of 2006 [6].

3.2.1. Austria

The Austrian solid waste management system is based on directive 2008/98/EC by the EU, which was transposed into a national law through the existing waste management law of 2002. The priority of the Austrian system of solid waste management is the protection of humans and the environment [7]. A participatory approach was adopted, where the entire population, municipalities, private companies, and stakeholders were involved [8].

Austria has recorded notable successes in the past twenty years in the field of integrated solid waste management, that it is now among the leading countries, with a recycling rate of municipal solid waste that reaches up to 69% [7]. The Austrian strategy for solid waste management includes the major elements explained in the following [8].

A) Waste reduction through waste prevention

By using surveys and interviews, Austrian municipalities started measuring public awareness of the concept of waste prevention and separation at the source. The collected data was used as a baseline survey to inform the design of a public campaign under the supervision of experts, and develop an action plan for waste prevention.

B) High rates of waste collection and recycling

The objective was to achieve a clean environment through a higher collection rate, increase the economic return by raising the recycling rate to 69% of the collected municipal waste, and reduce the volume of dumped waste (not to exceed 14%). Those goals were approached through various means including a system called "Industrial Ecology-Closed Loop", using waste as inputs for new processes, which results in zero waste and profitable environmental products (Figure 3). Many other techniques were also applied such as composting and energy production.

Figure 3. (a) Recycling of metal waste in Austria [9]; (b) Recycling plant for plastic in Austria [10].

C) Comprehensive strategic planning

The Austrian management scheme focuses on the entire management process in a long-term plan. Austrian municipalities started in the 1980s by preparing their objectives and their action plan until the beginning of 2000. The amount of generated waste was calculated each year; and several scenarios were developed based on the set national objectives. One of the objectives was to reduce the dumped waste by 71% as of 2014.

D) Safe and economic disposal of non-recyclable waste

In addition to the strict measures adopted by all municipalities, a more synergic approach has been followed in regard to non-recyclable waste disposal. As some areas are deprived of sufficient landfill spaces, the issue was solved by regulating a participatory use of shared landfills. This allows the use of existing landfills in neighboring cities within the landfill network, which turned out to be a cheaper option than establishing new landfill sites.

3.2.2. Greece

Greece is an EU country which relatively delayed the adoption of complete practices of solid waste management. However, in the last years it was compelled by international and European engagements to follow a concrete strategy in order to restrict unfavorable waste disposal. The finance from the EU, in addition to local financing programs, together constitutes the main resource for the current Greek national strategy for solid waste management.

Generally, 85% at weight of municipal solid waste is collected and transported by an organized system of collection, with an average rate of recovery that reaches up to 18% (Figure 4). The Greek strategy for solid waste management includes the major elements explained in the following [6].

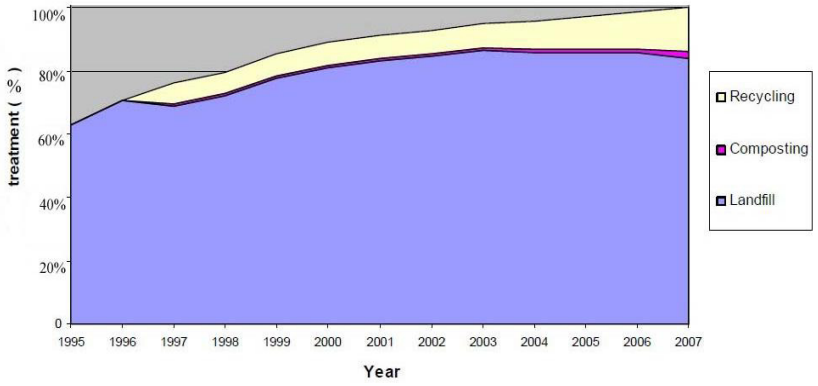

Figure 4. Development of municipal solid waste management in Greece, 1995 – 2007 [11].

A) National and regional planning

The Greek strategy for solid waste management was incorporated in two levels of planning: national planning (which includes basic principles, objectives, policies, and actions - according to the EU institutional frame - that are in harmony with the national conditions and obligations), as well as regional planning (which includes executive plans with specifications and objectives that coincide with the objectives of national planning). Furthermore, all works and actions of waste management are reported, while new proposals are gradually submitted and assessed.

B) Legislative, authoritative, and institutional roles

The main orientation of the Greek system for solid waste management is based on a local set of legislations. The most important directive was issued by the ministerial decision 50910/2727 in 2003 "Measures and Terms of Solid Waste Management". The main target of this directive was to establish an updated institutional framework with regard to the technical specifications and measures of integrated solid waste management. Within the designated framework, regional municipalities are responsible for the appointment of experts and objective interventions for the management of municipal waste, creating mechanisms which incorporate the private sector in the action plan.

C) Waste minimization

The Greek approach for solid waste management adopts waste minimization through the reduction of waste generation at the source, as well as the reduction of waste toxicity level. As municipal waste screening occurs at the source, the possibilities of reuse, recycling, composting, and energy recuperation are maximized. This is alongside the promotion of waste management technologies that are acceptable from a technical, economic, and environmental point of view.

D) Dealing with uncontrolled waste disposal

A work team of experts has been assembled in collaboration with units of technical support to contribute to the development of the Greek action plan for solid waste management, by setting special objectives regarding uncontrolled disposals. The plan targets a progressive obliteration of uncontrolled disposal practices, in addition to a country-wide supply of modern sanitary sites for safe waste disposal.

3.3. Nepal

As in many other developing countries, the management of solid waste has been a growing concern in Nepal. While Nepalese urban population increases and flat usable land is in short supply, many Nepalese municipalities still suffer from a lack of infrastructural and technical resources. Therefore, the international NGO (Non-Governmental Organization) "Practical Action" - Nepal Office, in association with the government, has initiated the project "Strengthening Local Capacities in Integrated Sustainable Waste Management" which took place in small and medium municipalities of Nepal, with financial support from the European Union. Empowered by the program, Nepalese municipalities were able to achieve rates of municipal waste recovery that reached up to 30%. The Nepalese strategy for solid waste management includes the major elements explained in the following [12].

A) Public awareness and the empowerment of local communities

Solid waste management has now come to the top priorities of Nepalese municipalities, as the Local Self Governance Act of 1999 has empowered municipalities to take every necessary action at the local level. Even though collection systems are still not totally in place, most municipalities are promoting waste reduction, reuse, and recycling among local communities, and many are making good progress (Figure 5-a). This is in addition to the recruitment and training of waste management staff, and informing the public about the waste management system.

B) Targeting higher recovery rates by providing incentives and role models

It is estimated that 20% by weight of municipal solid waste could be recycled by Nepalese municipalities, while up to 10% by weight of organic waste has been used for composting. Nepalese municipalities took the initiative of providing role models to the public by operating recycling plants, and using recovered products like recycled paper for their office stationery. In addition, Municipalities promote composting by the sale of subsidized compost bins which fit the use of households, while they buy recovered segregated waste materials at reasonable prices.

C) Offering opportunities for employment and expanding resources of funds

The solid waste management system in Nepalese municipalities has created many job opportunities for the locals, either as inspectors, drivers, collectors, or others. The revenue of such municipalities is derived from property tax, municipal tax, and compulsory fees paid by residents and businesses, besides local and foreign grants.

D) Safe land-filling

The Nepalese system insured that up to 70% of waste was being safely disposed of. Landfill sites that have started to operate since 2005 were equipped with modern sanitary features. Moreover, trees have been planted and beehives installed around such sites to improve the environment and provide another source of income (Figure 5-b).

Figure 5. (a) Competition on waste recycling, organized by Practical Action [12]; (b) Tree plantation and beehives at Nepalese landfill sites [12].

4. Solid waste management in Egypt

The challenges of Solid Waste Management in Egypt have always been one of the most pressing challenges facing the Egyptian authorities. During the 1990s, Egypt followed the Structural Adjustment Program (SAP) that was introduced by the International Monetary Fund (IMF) and the World Bank. One of the reform objectives was to liberalize the economy by increasing the involvement of the private sector in operating public projects. Within this context, the private sector (particularly international companies) became involved in the management of solid waste in Egypt. After years of international private sector participation, the situation has deteriorated as admitted by the Minister of State for Environmental Affairs in a report issued in 2009. The report estimated that the annually generated solid waste in Egypt reached nearly 75 million tons, while municipal waste was about 20 million tons [8].

4.1. Municipal solid waste generation and treatment in Egypt

Municipal waste represents nearly 25% of the generated solid waste in Egypt. In Greater Cairo, the situation is very critical because of the high density, as well as the deficiency in management systems [8]. It is also important to note that waste generation and disposal statistics in Egypt can be unreliable, since there are no weighing facilities at disposal sites and no tradition of waste sampling and analysis [13]. Furthermore, the types and quantities of waste vary widely according to locations and urban patterns (Figure 6).

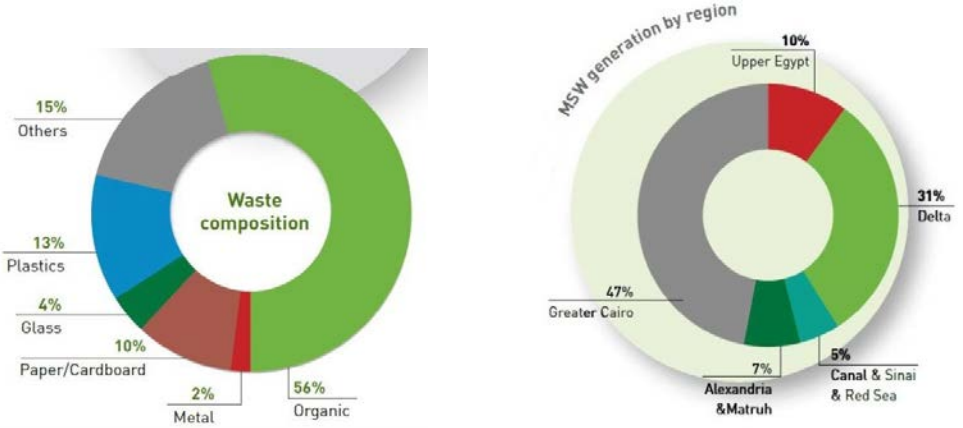

Figure 6. (a) Municipal solid waste composition in Egypt [14]; (b) Municipal solid waste in Egypt by region [14].

4.2. The Egyptian legal framework for solid waste management

Since Egypt does not have a solid waste management law, the legal framework for solid waste management is scattered in many pieces of legislation. The two most significant legislations are Law No. 38/1967 for General Public Cleaning and Law No. 4/1994 for the Protection of the Environment. Additional updates of legislations within 2005-2010 are listed below [14]:

- Law No.10/2005, establishing a solid waste collection fee system.
- Prime Minister Decree No. 1741/2005, amending the Executive Regulations of Law 4/1994, and covering regulations for the selection of sites for recycling, land-filling, and equipment requirements for waste collection and transfer.
- Law No. 9/2009, amending Law 4/1994 and regulating disposal of hazardous waste.
- Presidential Decree No. 86/2010, regulating the closure of existing dumping sites and landfills at Greater Cairo, and allocating five new sites outside the belt of Greater Cairo.

4.3. Concerns about the situation of solid waste management in Egypt

- The total annual municipal solid waste generation in Egypt has increased by more than 36% since 2000 [14].
- Less than 60% of the generated waste is operated by public and private sectors. The rest accumulates on streets and illegal dumping sites, which indicates that the management system is mostly inefficient [14].
- More than 80% of the generated municipal solid waste in Egypt is simply dumped, as the overall recovery rate has not exceeded 11.5% [14].
- Solid waste management in Egypt is dispersed among more than one structure/ministry that lack the vision of cooperation and planning, as each ministry or structure approaches every management process separately [8].
- Although the Egyptian government commenced several initiatives to develop the waste management sector by the beginning of the new millennium, the actual efforts resulted in very little improvement [14].
- The problem has been aggravated by the lack of effective legislations, a coherent and direct legal framework, in addition to the limited funds and the inability of municipal authorities to provide reliable services cost-efficiently.
- The issue of public awareness and citizen behavior toward solid waste management was never considered or directly addressed by the authorities [8].
- The situation is causing serious environmental problems. In fact, the improper disposal of solid waste in waterways and drains has led to the contamination of water supplies, which compromises Egypt's natural resources and public health.
- As a result of the bad performance of solid waste management in Egypt during the last decade, the level of street cleanness has deteriorated badly, and the pollution resulting from garbage incineration has increased highly [8].

5. Sustainable strategy for solid waste management in Egypt

In the light of the previously studied leading models in various countries, as well as the current situation of the Egyptian case, a sustainable strategy for integrated solid waste management in Egypt can be formulated as shown in the following (Table 1).

Table 1. Summarized strategy, suggested for sustainable solid waste management in Egypt.

Main strategic axes	Description
National planning	Developing and implementing a national well defined policy, aiming essentially to reduce waste generation.
	Establishing a national program for source separation and a reliable collection system.
Legal framework	Issuing a direct and unified national law for solid waste management.
Private sector incorporation	Adopting suitable mechanisms to enhance private sector participation in the solid waste management system, which must be a main policy within the national strategy.
	Finding a suitable mechanism to integrate the informal sector (garbage dealers) in the privatization process.
Finance and cost recovery	Applying the "polluter pays" principle as another important policy of the strategy, in addition to the extended "producer's responsibility" principle as means to enhance waste recycling.
	Allocating an annual budget by the government for the solid waste management sector until a sufficient and more advanced cost recovery mechanism is achieved.
	Allocating a sufficient budget for investments to remove waste accumulations, improve collection systems, and establish transfer stations, recycling centres, and sanitary landfills.
	Subsidizing solid waste management projects that reduce the generation of pollutants and greenhouse gas emissions.
	Exploring and enacting the potential revenue derived from existing government-owned composting facilities after their rehabilitation.
Management and monitoring	Establishing a monitoring and evaluation system in each governorate for solid waste management, with specific roles and responsibilities.
	Improving the managerial and marketing skills for waste management staff.
	Developing a reliable database by applying accurate techniques for measuring the annual generated quantities of different waste types.
Training and capacity building	Implementing capacity building and training programs for municipalities' staff country wide in planning, contracting, as well as implementing and monitoring solid waste management services.
	Establishing a national capacity building program to integrate the technical, conceptual, and social skills required to facilitate multi-stakeholder participation.
	Implementing human resource development programs for those in charge of operating and maintaining the equipments used in solid waste management.

For such strategy to be executed, an action plan has to be developed in compliance with the mentioned strategic axes. Priority should be given to an immediate framework that addresses influential key issues as summarized in the following (Table 2).

Table 2. Primary framework for sustainable solid waste management in Egypt

Main target	Proposed actions
Enhancement of solid waste management systems	Increasing efforts for the removal of solid waste accumulation in all urban areas.
	Extending solid waste management services to rural areas as a priority and involving non-governmental organizations and local contractors.
	Reducing the gap between the current performance and the strategy targets by improving the collection coverage, closing existing improper dumpsites and establishing sanitary landfills for disposal, enhancing waste recovery procedures, and adopting source separation and source reduction mechanisms.
Waste valorisation	Developing a formal recycling sector by establishing central recycling centres on the national level, and setting up standards for recycling industries and recycled products.
	Adopting new treatment technologies such as biogas and waste-to-energy projects, as well as creating recycling centres for specific waste types like electronic discards.
Public awareness	Adopting a national communication plan in collaboration with the public media in order to increase the participation and raise awareness, especially on hazardous waste.
Networking and partnership	Re-structuring the solid waste management sector efficiently (steering committees, terms of reference, members and roles, regular reporting and assessment systems, etc).
	Preparing and updating a database of contacts, areas of expertise, and any relevant information about the institutions and practitioners involved in solid waste management.
	Sharing technical expertise, information, educational resources, and opportunities between the network members and organizations.
	Establishing a hub for Egypt's waste management data.
	Developing a set of indicators to assess the network progress.
	Creating an electronic environment for knowledge sharing.
Technical support	Providing logistical support for the national network to the furthest possible extent.
	Designing and updating manuals and guidelines on the proper practices of solid waste management.
	Providing assistance to organize regular workshops and seminars (to be presented by the network experts).
	Providing technical support to fill the gaps and help developing a national database that covers all activities of the solid waste management sector.
	Offering assistance to any other programs dedicated for raising awareness and capacity building.

6. Recommendations

- Minimization of solid waste at the source: in order to efficiently realize this target in Egyptian urban centers, an effective collection system is essential, while local authorities, private sectors, and NGOs must work together to improve the current practices and develop policies within this area.

- Establishment of proper landfill sites: a safety upgrade is required for all current Egyptian disposal sites to apply modern land-filling features, in addition to the need for establishing new sites according to appropriate standards.

- Waste management as part of the initial infrastructure: for any type of construction, either residential or commercial, basic requirements should be enforced for the reduction and segregation of waste at the source (municipalities could consider measures such as the inclusion of separate containers for composting and recycling before approving a construction proposal for a new building).

- Greater participation of local communities: as previously demonstrated, public awareness is a main key to the upgrade of waste management. However, it is mostly the government responsibility to organize public participation and initiate awareness programs.

- Monitoring while supporting private sector partnership: due to the limitations of government finances and resources, engaging waste management service providers from the private sector is a viable option. However, to avert past deficiencies, a proper and just investment environment must be granted, and necessary policy measures must be made for the authorities to monitor and assess the performance of private sector partners.

- Involving local recycling businesses in waste management planning: local dealers in this business have the experience that could improve the planning process and its outcomes.

- Incentives and tax waivers for recycling activities: waste recovery could be highly encouraged by waiving government taxes for any recycling business in every Egyptian municipality. Moreover, competitions and valuable awards should be offered for the best practices.

- Greater effort for community composting: composting is the best option for treating organic waste, especially in agricultural developing countries like Egypt, where the highest percentage of solid waste is of an organic nature.

- Simple and dedicated programs for specific kinds of waste: for inorganic waste like plastic, glass, paper, and metal, local municipalities should provide the tools for effective separation, storage, and transportation (such as the use of coded bins and appropriate trucks, etc.).

- Empowerment of low-income communities for recycling: low-income communities, if properly trained, could recycle their own waste themselves in their areas, thereby allowing them to make extra income, besides improving the public perception of waste management.

- Awareness mechanisms to encourage the public: interactive programs, television and radio broadcasts, educational tours, exhibitions, and other similar means should all be used for dissemination and to encourage citizens to take on a greater role.

- Training services: the Ministry of Local Development with the participation of NGOs could formulate clear and more extensive solid waste management training services and resource centers in all the municipalities of Egypt.

- More research and studies for a national plan: an effective national plan for sustainable solid waste management should be approached in collaboration with academic research institutions and universities from all over Egypt.

- Short-term and long-term planning: all municipal administrations should develop short-term and long-term waste management plans including visions, targets, responsibilities, time frames, monitoring, and constant assessment.

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